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PSYCHOLOGICAL LITERATURE.

I. SOME RECENT STUDIES OF PAIN.

1. *Pain, Pleasure and Aesthetics.* MARSHALL. London, 1894.
2. *Beiträge zur Physiologie des Schmerzsinns.* PROF. DR. M. VON FREY, Ber. d. math.-phys. Klasse. d. k. Sächs. Ges. d. Wiss. July and December, 1894.
3. *Die Sensibilität der Conjunctiva und Cornea des menschlichen Auges.* DR. W. A. NAGEL. Pflüger's Archiv, Bd. LIX, 1895, pp. 563-595.
4. *The Origin of Pleasure and Pain.* DR. H. NICHOLS. Phil. Rev., I, pp. 403-432, 518-534.
5. *Schmerz und Temperaturrempfindung.* PROF. DR. Z. OPPENHEIMER, Berlin. Georg Reimer, 1893.
6. *Ueber den Schmerz.* PROF. DR. A. GOLDSCHIEDER. Berlin, 1894.

Says Goldscheider, in his recent work, "Ueber den Schmerz," "It is a shame that we possess such insufficient knowledge concerning the character of pain—those symptoms which represent the essential part of all bodily suffering of man." This statement is true if we have in mind our knowledge of the origin and mediation of pain; *i. e.*, whether it is of physiological or of psychical origin; whether it is mediated by specific nerves, or by any or all sensory nerves; whether pain is to be considered as a *quale* of a sensation, a separate, coördinate sensation, or only an intense degree of a sensation;—for on all these points our knowledge of pain is far from satisfactory. On the other hand, if we have in mind the many facts we know concerning pain, its influence on our mental and bodily states, its importance as a guide to health or disease, as well as its value in leading to higher moral and religious action, there is, perhaps, no sensation about which we know more. The difficulty in finding a theory for pain is due, perhaps, in large part, to the great number of isolated facts we already know concerning it. If we knew less we might be willing to accept any one of the many theories already proposed, but as it now is, no theory seems to answer all. The primordial character of pain makes it one of the most difficult of experiences to analyze. It comes to us after untold ages of accumulated experiences, mixed with other, later-developing sensations, from which it is next to impossible to separate it.

Some of the Known Facts.

What are some of the isolated facts that we know concerning pain? To enumerate, without endeavoring to follow any particular order, we may state:

That a stimulation of pressure (touch) is perceived sooner and fades away quicker than a painful stimulus occurring at the same time and in the same place—that is, under normal conditions, pain and touch excitations occurring together are separated in time before reaching consciousness. Again, under the influence of anæsthetics, pain and not touch may be temporarily destroyed, or *vice versa*; for instance, cocaine and chloroform destroy pain and not touch, while saponin destroys touch and not pain. Under clinical and pathological conditions, such as traumatism, syringomyelia, etc., pain may be destroyed without any other sensation being materially injured. Sectioning the gray matter of the spinal cord destroys the perception of pain from parts below the section, without destroying the sense of pressure (touch).¹ In multiple neuritis and certain lesions of the cord, the sense of touch may be destroyed without that of pain. Pain may be produced by an electric spark, or by thermal stimuli, without any sensation of touch.

Again, as shown by Naunyn and others, pain is the result of a summation process. Naunyn² found, in cases of tabes dorsalis, that a mechanical stimulus (produced by touching the skin of the foot with a hair, etc.), which is below the conscious threshold of either pain or touch, if repeated a great many times per second (60 to 600), will be perceived, after a few seconds (6 to 20), as a pain which soon becomes unbearable. The same effect of summation can be shown with electric stimulation, where, with a weak current, a few shocks per second are not painful, but a large number per second are decidedly so.

Notwithstanding the above cases, in which it seems possible to separate pressure (touch) and pain, yet normally, especially under mechanical stimulation, pain is seldom found without being preceded or accompanied by touch. It is probably the mixing of these different cutaneous sensations with pain that enables us to locate the latter, and gives to it the peculiar coloring which we designate as acute, sharp, smarting, stinging, boring, lacerating, lancinating, griping, gnawing, aching, bearing-down, etc., according as the painful feeling is mixed more with one or another of the cutaneous sensations. Owing to the insufficiency of language to express such states of consciousness, it is difficult to make the above terms more simple, or even to be sure that the same term is used for the same thing by different individuals. A pain may vary, of course, through any or all of these different qualities at different times.

Pain, according to Erb,³ is not a sensation of a peculiar form, but one of higher degree; therefore, every sensory stimulus is capable of producing pain, if it reaches sufficient intensity. But we can hardly retain this statement among those of generally accepted facts, for the statement is questioned by those who hold that the higher senses (sight, hearing, etc.), as such, do not give physical pain. On the other hand, every kind of stimulation, mechanical, thermal, electrical and chemical, may excite pain. Any disturbance of nutrition or of circulation may also produce the same result.

Pain is generally accompanied or followed by inflammation of the parts, but what particular relation this bears to pain is not known. Most would agree that, in many cases at least, the pain was due to the inflammation; but Radcliff⁴ and some others take the ground

¹ Schiff, "Lehrbuch der Muskel- und Nerven-Physiologie," S. 251 ff.

² Arch. f. experim. Pathol. u. Pharmak. Bd. XXV. S. 272 ff.

³ Krankheiten der peripherischen cerebro-spinalen Nerven, 1874.

⁴ Radcliff, *Lectures on Epilepsy, Pain Paralysis, etc.*, London, 1864. John Churchill.

"that pain of a neuralgic character is antagonized rather than favored by inflammatory excitement of the nervous system." And, further, "where pain seems to be associated with active fever and inflammation, it has been seen that the place of the pain is in the cold stage, before the establishment of the hot stage of the disorder, and not in the hot stage itself—in the stage of irritation preliminary to the inflammation, and not in the stage of actual inflammation." As is well known, pain is a very important sign of disease, and becomes of great value to the physician in his diagnosis, but the pain is very often located at a distance from the seat of the disturbance. For instance, disease of the hip-joint causes pain in the knee; inflammation of the liver, or in the diaphragm, causes pain in the right shoulder; valvular lesion of the heart may produce pain in the left arm; irritation of the stomach may cause pain in the head; stone in the bladder may produce pain in the outlet of the urinary passage; spinal lesions are nearly always referred to some more peripheral part.

Individuals, as well as nations, differ greatly in their sensitivity to pain. The Irishman is more sensitive than the Scotchman; the Latin race is more sensitive than the Teutonic. There are age, class and sex differences, though the data here are very limited (Lombroso, and later MacDonald¹). It is also true that the same individual differs considerably from day to day in his sensitivity to pain without any apparent cause.

Again, a mechanical (pressure) stimulation, which is not at all painful at first, will, if long continued, become not only unpleasant and annoying, but actually painful. Here continuation of pressure seems to change a touch sensation into a painful one. There are some parts of the body, *e. g.*, the cuticle, nails, hair, ligaments, etc., that are never painful; while there are other organs, *e. g.*, the lungs, liver, kidneys, intestines, mucous membrane, tendons, etc., which, under normal conditions, function painlessly, but under pathological conditions become the seat of very severe pain.²

To the above may be added the pains due to general depression, fatigue, hysteria, hypnotism, etc. By hypnotic suggestion the body may, on the other hand, be rendered insensitive to pain, while all other sensation remains intact (Witmer³).

Still another interesting fact has been brought out by Nagel, namely, that a current of hot air striking the conjunctiva, cornea or mucous membrane of the tongue, is never perceived as warm, but as cold, unless too hot, in which case it feels cold and painful. The other parts of the body, however, perceive the warm current as warm.

Some Recent Theories of Pain.

In order that any theory of pain may be accepted as final, it must explain all the above facts as well as many others not mentioned. There are almost as many pleasure-pain theories as there have been writers upon the subject, and the subject has by no means suffered for want of writers. Each theory may be satisfactory to the man who proposed it, but few can be said to be satisfactory to large numbers, while none seem to be satisfactory to all.

I wish to confine myself in this article to a few of the recent theories of pain, which cover pretty nearly the present status of the subject. These theories may be divided into three groups:

¹ AM. JOURN. PSYCH., Vol. VI, p. 621.

² Oppenheimer, "Schmerz und Temperaturempfindung."

³ *The Journal of Nervous and Mental Disease*, April, 1894, p. 219, note.

1. Those which represent pain as a *quale* of sensation.
2. Those which class pain as a distinct sensation.
3. Those which class pain simply as a certain degree of sensation.

Under the *quale* theory may be classed nearly all the ancient writers on the subject as well as many of the present day. By far the best exposition of this theory is given by Mr. Marshall in his recent book, "Pleasure, Pain and *Aesthetics*." This most excellent treatment of the subject has given a new impetus to the *quale* theory as well as to the whole study of emotion. A careful reading of the book makes one feel that there is but little left to be said on that side, and one must admit the great importance of the work, even though he may not be able to bring his mind to harmony with the author's view.

Marshall gives three hypotheses to account for pain and pleasure, of which he accepts the last: (1) "That pleasure-pain modes are the fundamental elements from which all mental life develops, a hypothesis which, apart from other oppositions, is negatived by the fact that our mental life is not developed on two distinct lines, viz., of pleasure and of pain." (2) "That in pleasure-pain we have a special mode of mental activity, a series *sui generis*, unlike and standing apart from any other mental state in character and means of genesis, which, however, is connected with all other mentality in some subtle way." (3) "That pleasure and pain may be differential qualities of all mental states of such nature that one of them must and either of them may, under their proper conditions, belong to any element of consciousness." "Under these hypotheses pleasure and pain are primitive *qualia*, which may appear with any mental element; simple, primitive ideas in the Lockian sense, and, therefore, correctly classed by him; simple primary differentiations of presentation, which are grasped by us essentially after the same manner in which we know the mind to act in other directions, but in the most primal forms of such action." Mr. Marshall says further: "That psychic life is not divided on the lines of pleasure, is no objection to a view which makes pleasure and pain *qualia* of all presentation composing our psychic life as we know it, for the distinctly marked-off psychic states are not supposed to be developments from the pleasure-pain modes, but states still subject to these qualifications.

As to the physical basis of pain, he holds that "no special nerve organs and no distinct differentiations of such organs are to be looked for to account for the *qualia* which relate to the whole field of mental life, for their physical conditions, whatever they be, must be looked for in all that which we learn to look upon as the physical basis; *i. e.*, in all of nerve necessary for mentality whatever special parts are, for any one moment, called into activity. Each case of distinct presentation may thus be said to bring forward its own pleasure or pain organ, as it were, fitted to act under proper conditions." The old Aristotelian idea that "the activity of the organ of any content, if efficient, is pleasurable, if inefficient, is painful," is discussed and changed to the following principle: "All pleasure-pain phenomena are determined by the action in the organs concomitant of the conscious state, as related to the nutritive condition of the organs at the time of the action."

In particular his hypothesis is: (1) that "pleasure is experienced whenever the physical activity, coincident with the psychic state to which the pleasure is attached, involves the use of surplus stored force—the resolution of surplus potential into actual energy, or, in other words, whenever energy involved in the reaction to a stimulus is greater in amount than the energy which the stimulus habit-

ually calls forth;" and (2) that "pain is experienced whenever the physical action which determines the content is so related to the supply of nutriment to its organs that the energy involved in the reaction to the stimulus is less in amount than the energy which the stimulus habitually calls forth." Or, in other words, that "pleasure and pain are primitive qualities of psychic states, which are determined by the relation between activity and capacity in the organs, the activities of which are concomitants of the psychoses involved."

Without quoting farther, we may sum up Mr. Marshall's positions as follows: (1) That pleasure and pain are general qualities, one of which must, either of which may, belong to any fixed element of consciousness. (2) That emotions are the psychic coincidents of relatively-fixed, coöordinated, instinctive activities arising upon the appearance of definite objects, and, therefore, only indirectly connected with pleasure and pain. (3) That aesthetics should be treated as a branch of hedonics, or the science of pleasure. (4) That pleasure and pain are determined by the efficiency and inefficiency, respectively, of the organs active in coincidence with the pleasurable or painful mental elements; that efficiency and inefficiency are functions of the relation between activity and nutrition, pleasure being dependent upon the use of surplus stored force, and pain upon conditions under which the outcome of the organ's activity is less than should be expected in consideration of the energy involved in the stimulus.

It seems more proper to designate Mr. Marshall's classification of pain and pleasure as a psycho-physical than a psychological one, and yet his pleasure-pain theory is distinctly psychological, making pain and pleasure due to psychic states as wholes, rather than to the disturbance of any particular organ. Under his treatment, his theory becomes exceedingly flexible, and seems capable of answering nearly all the known facts. He says, in reference to those pains which often seem separate or distinct in themselves, that they do not invalidate his theory, for, under extreme conditions of excess of activity as related to nourishment, the psychosis of relation should be vivid. Pains from organs which are normally not painful, but which become so under hypernormal conditions, are due to the fact that these organs are normally so regular in their rhythm that they are not called upon to act powerfully, and, therefore, have little capacity or use for surplus stored force, consequently any hypernormal condition would cause them to act painfully. The same reason may account for some organs being incapable of pleasurable stimulation.

As to the secondary sensation, occurring in case of a prick, he assumes a second set of nerves, which are brought into action after touch, and respond painfully on account of their little storage capacity. Analgesia, he says, may be answered by one sense being obliterated, while the other is not cut off. But it is difficult to understand how either of these statements can be made to coincide with his theory. In the first statement he has separated the pleasure-pain *quale* from touch, and has made it include the whole of the secondary sensation. In reference to the second statement, if the *quale* may be separated from the sensation, either by different paths of conduction or by disease, there would then be a *quale* without a sensation, or a sensation without a *quale*; either of which would seem fatal to the *quale* theory. It has been shown quite conclusively, however, by Schiff and others, that pain has a different path of conduction in the spinal column from most of the other haptic sensations. To say that under certain conditions the *quale* may

become so intense as to blot out the rest of the sensation, is not satisfactory, for what reason have we to say the rest of the sensation is there, only obscured from consciousness? Furthermore, pain not only occurs frequently unaccompanied by other sensory elements, but may be located at a distance from the seat of the disturbance, and also seems to have a quality of its own. Again, it may be asked, should not the quality of a sensation become more noticeable with practice (exercise), *i. e.*, the quality of wine by experience in tasting—the perfume of flowers by experience in scenting—tints or shades of color of a visual sensation by practice in seeing? Exercise, however, seems to increase instead of decreasing the pain threshold.

According to the *quale* theory, it would not seem possible that the injury of any organ could take place without pain, yet, as is well known, the liver, lungs, kidney and some other internal organs can be cut or in many ways injured without pain, and is it not possible to develop the use of narcotics, to the injury of the whole system, without pain?

Again, as Witmer says,¹ "To assume that every sensation or mental state, whatever, may be presented in the extreme of pleasure, in the extreme of pain, and in any pleasure or pain intensity between these and indifference, would require that quinine, in proper intensity, should give a pleasure equal in intensity to that of the exercise of the sexual function; that the odor of violets, in sufficient intensity, should give a pain as decided and intense as the agony of angina pectoris."

It does not seem to me that this theory can be made to account adequately for the different facts of pain, nor does it seem to me that pain is simply the opposite of pleasure. Real pain often seems as distinct in itself as any other sensation, while pleasure never seems distinct from the sensations or associations which produce it.

Among those who hold the view that pain is a sensation mediated by specific nerves of pain, Prof. M. von Frey of Leipzig has given, perhaps, the best experimental proofs, while Dr. Herbert Nichols of Harvard has presented, I think, the most plausible theory, based on the assumption of specific pain nerves. As these two views seem to represent pretty clearly this side of the subject, I shall give a brief synopsis of both.

Von Frey gives the result of his experiment in two articles, the first published in July and the second in December, 1894.² He used as apparatus a great number of light sticks, 10 cm. long, to the end of each of which was attached a hair, forming a right angle with the stick. These hairs varied in length from two to three centimeters, and in size from the downy hairs of a child to the firmest bristles of animals. By a very delicately poised scale, all these hairs were graded, with reference to the force necessary to cause them to bend. A section from the end of each hair was measured under the microscope to get the area over which the pressure was exerted.

With this series of graduated hairs, von Frey could reduce all his measurements to a common unit, which he did in terms of grams per square millimeter; *i. e.*, the number of grams pressure necessary to produce a sensation of touch or of pressure when the contact surface equaled one square millimeter. With this carefully prepared apparatus, he mapped out by a series of pressures the

¹*Journal of Nervous and Mental Disease*, April, 1894, p. 213.

²"Beiträge zur Physiologie des Schmerzsinnes," Ber. d. math.-phys. Klasse d. Königl. Sächs. Ges. d. Wissenschaften. Leipzig, July, 1894; December, 1894.

touch threshold, as well as that for pain, for different parts of the body, giving his results in $\frac{\text{gr.}}{\text{mm.}^2}$. He finds the lowest threshold on the cornea and conjunctiva where he gets pain only. He says: "The hairs exhibit the most sensitive touch apparatus of the body, and the next to the hairs come the hair-bulbs." There are many points in the neighborhood of the hair-bulbs that give only pressure (touch) sensation. Separated from these, and brought out by a greater stimulus, are pain-points. The pain-points are more numerous than touch-points, and are generally found in the places between hair-bulbs. The touch and pain-points are separated by insensitive places. The pain-points, as well as those for touch, vary much in threshold value on different parts of the body. In his first article, he reaches the following conclusions: (1) The punctiform stimulation of the skin, with a gradual, mechanical stimulus, allows the demonstration of two thresholds—a lower one for pressure and a higher for pain sensations. Pressure and pain-points lie locally separate, the former in the neighborhood of the hair-bulbs. (2) There are certain surfaces of the body sensitive to pressure and not to pain, and other surfaces sensitive to pain and not to pressure. The pain-points have, consequently, only a single threshold, which need not lie higher than the pressure threshold of the skin, and may lie even considerably lower, as in the cornea. He concludes, therefore, that the pain sensation is mediated by a special arrangement of pain-points and pain nerves.

The first part of von Frey's second communication is largely supplemental to the first communication. He studies more carefully the relative threshold between neighboring touch and pain-points, and finds the threshold for the latter much higher, except of course on the cornea and conjunctiva, where he thinks there are no touch-points. The relative threshold (pressure threshold, divided by pain threshold) on the arm for mechanical stimulus is given as $\frac{1}{4}$, and on the ends of the fingers as $\frac{1}{5}$ to $\frac{1}{6}$.

The second part of the second communication is the result of a study of these same touch and pain-points by means of electrical stimulation. He finds that touch and pain-points can be located by electrical as well as by mechanical stimulus, the former yielding a whirring, jarring sensation, the latter a pricking sensation. The difference between the threshold of the touch and pain-points is much less when electrical stimulation is used instead of mechanical, or, as von Frey says: "[In electrical stimulation] the threshold of pain-points lies in many places lower than that of pressure-points; the relative threshold is thus greater than 1." There is as much variation in the threshold of different pain-points on different parts of the body as there is between neighboring points of different kinds of sensation.

There is great difference in the inertia of touch and pain-points; the former begin and cease acting quicker on stimulation than the latter. Pain, therefore, accumulates or summates out of proportion to the stimulus, while touch does not. Von Frey has convinced himself that on the extremities 130 shocks per second can be easily distinguished, while 20 shocks per second on a pain-point cannot be distinguished, but are perceived as a continuous sensation. The after-image is, therefore, much more persistent for pain than for touch. The inertia of these points can be shown equally well by mechanical stimulation.

Von Frey concludes by reaffirming his belief in separate pain nerves, with their appropriate end organs. Pleasure nerves he does not assume, but as black is the absence of color, so pleasure is

the cessation or absence of pain.

Dr. Nagel¹ has made a similar study of pressure, pain and temperature points, and from a greater number of cases draws conclusions which are, for the most part, contrary to those obtained by von Frey. Among Nagel's conclusions are the following: The statements of von Frey that the conjunctiva and cornea are capable of painful sensations only, is not correct. The error is explained through the one-sided use of stimulating hairs (which really prick) for the testing of sensibility. By the avoidance of the pricking effects, one obtains pure touch sensations on the conjunctiva. Painless touch sensations are, likewise, easily produced on the cornea under suitable conditions of examination, best through touching the surface with soft, moist and warm objects. Light touches of short duration with the point of a hair are also painless. The physiological proof of pain nerves and of pain-sense organs presented by von Frey, as well for the cornea and conjunctiva as for the body in general, is not made out in a convincing manner.

The finding of spots over the body, where the surface responds painfully to very much weaker stimulus than in other neighboring spots, does not, necessarily, indicate pain nerves and pain end-organs, for, as is well known, the delicate epithelial tissue is covered over with the insensible cuticle. This latter covering consists of scales or cells, which are very much thicker in some places than in others. Where the little furrows caused by the transverse folds of the skin cross each other, we find the most pain-points, as would be expected if these pain-points were due to the absence of protecting cuticle.

Again, the touch-points and the indifferent spots respond painfully if the stimulus is intense enough. This von Frey admits, but says it is due to the disturbing of neighboring pain nerves, which may be true, but the evidence for such an assumption is very meagre. I shall return to this again a little further on.

Dr. Herbert Nichols,² on the assumption of specific nerves of pain, proposes a theory for pain on the basis of a supposed biological development.

According to Nichols pain nerves are developed only for the purpose of responding to excessive stimulation, as a warning against violent and injurious influences, and in this they differ from the nerves of other senses, which respond to weaker stimulation and cease acting as soon as the stimulus becomes so intense as to be injurious to the proper functioning of the parts. "The nerves of sight, sound, heat, and so on, would, according to this, respond throughout the range to which they had been differentiated. When the more violent range was reached, which was injurious to them and beyond which they could not perform their function, there the sight would cease, and the nerves of pain would take up the functions to which they had peculiarly developed because of the fact that they could endure them with benefit to the creature from their warnings. Under such an arrangement it would not be necessary that the two ranges, say of sight and of pain, should wholly exclude each other, for it would be well for the warnings to begin before sight was entirely destroyed." Stimuli giving touch and pain, therefore, do not affect the same nerve simultaneously, according to the traditional view, but each sensation is mediated by a separate nerve.

¹ Wilibald A. Nagel, "Die Sensibilität der Conjunctiva und Cornea." *Pflüger's Archiv*, 5 Feb., 1895, Bd. LIX.

² *Phil. Review*, Vol. I., 1892.

This accounts for the frequent separation of pain and touch in consciousness.

As to pleasure, Nichols is not sure that pleasure should be looked upon as a separate sensation in any such sense as pain, and, therefore, pleasure nerves may not exist. However, the pleasures of sex and the pleasures of eating seem to approach more nearly in their distinctiveness the sensations of pain, and may yet be found to be due to specific nerves of pleasure. According to Nichols, pleasure is the primary sense from which all other senses were developed. As each new sense was differentiated, it assumed part of the primary activity of the pleasure sense, which in turn lost just that amount of its former activity. In this way, as the different senses become differentiated, the pleasure sense becomes less and less distinct, and more given to the centro-neural functions. Those senses earliest differentiated would contain the largest element of pleasure—as nutrition and reproduction. "Though the peripheral fibres of our primary sense system have, therefore, been largely submerged and their functions lost, its central parts, with their functions and their particular mental characteristics, have yet been preserved to us essentially unaltered." In another place Nichols says: "The great bulk of our æsthetic feelings unquestionably are associations and of central origin," which harmonizes with his view of pleasure. "It is the ideas associated with the different sense perceptions, and called up by them, that determine them æsthetically."

Nichols would explain the temperature pains by assuming that the pleasure and pain nerves end in different kinds of tissue, which are so constituted that the heat tissues are actively contracting when the cold tissues are either passive or actively expanding, and that the cold tissues are actively contracting when the heat tissues are passive or expanding. "If, now, we assume, by way of hypothesis, that both pain and pleasure nerves also end in each of these kinds of tissue, and that each kind of such nerves is susceptible to a peculiar intensive range of stimulation, we may form an idea of how our common temperature comforts and discomforts may be explained thereby . . . It may be easily understood, then, how pain, having developed to warn against too intense temperatures, and pleasure, having developed to prompt to certain conduct best suitable to certain moderate degrees of temperature, that they should thus have grown up sensible only to ranges of temperature mutually exclusive of each other."

Whatever may be said of the plausibility of the theories of pain and pleasure based on the assumption of specific nerves, it still remains doubtful whether such nerves exist. In fact, it would become almost as difficult to explain the reason for such nerves as it is to explain the phenomenon of pain and pleasure without them. For it is difficult to understand how so complex an organism, as pain nerves would indicate, could have developed without continual use, and even if in earlier stages of development such nerves did have use and experience, why has nature not tended to abort them during the long periods of disuse? And yet, one must admit that the nervous mechanism seems always ready to discharge in pains, which may not have been experienced for generations and may not be felt for generations to come. Certainly there would be no economy in nature in thus keeping constantly ready a complex mechanism whose office might well be performed by other already useful nerves. Many persons go through life without ever having experienced a pain in certain of the internal organs; and yet no one doubts that such pains might be called forth at any moment by

the right kind of disturbance. If the assumption of pain nerves is correct, why are many organs, like the intestines, liver, kidneys, etc., sensitive to pain only in pathological conditions? Must we assume different kinds of pain nerves? Pain and pleasure are, without doubt, the first conscious activities of life. If, then, their existence be due to specific nerves, it would hardly seem probable that these nerves, the first to function, should have eluded all investigations. Again, if pain nerves exist, we should expect that the exercising of them would increase their sensibility, while the opposite is true, at least, so far as present experimentation has shown.

A touch with the point of a needle in the palm of the hand will often produce, first, a sensation of touch, and, after a second, another distinct, long-continuing sensation of intense itching; on stronger stimulation, there may be first touch and pain, followed by a long-continuing sensation of itching. Shall we, therefore, assume itching nerves and itching points?

Attention plays such a great part in pain that to locate pain-points in the manner pursued by von Frey would require a great many trials with certainty of the spot and constancy of the pain; for, if stimulation of a point was made on the crest of a wave of attention, it would seem more sensitive than another stimulated at a less opportune time.

The assumption of pain-nerves must mean separate end-apparatus, separate paths of conduction, and most likely a separate pain-centre, or pain cells. The existence of such specific neural apparatus is by no means probable.

In reference to those who hold that pain is simply an intense degree of a sensation, and not necessarily an element of every sensation, there are two theories which I shall mention. The first is contained in the exceedingly interesting one of Prof. Z. Oppenheimer of Heidelberg, entitled "Schmerz und Temperaturrempfindung."

Oppenheimer begins his treatment of the subject by presenting some of the different views regarding pain and some of the known facts in regard to anaesthetics, inflammations, etc., and then sets himself "to examine how the effect of the pain-exciting influence is brought about, what parts of the organism are concerned in it, with what nerves these parts are connected, and in what relation to the central system these nerves stand."

1. As to the origin of pain. After examining at some length the cause of pains produced by various stimuli—mechanical, thermal, electrical, chemical, etc.,—Oppenheimer concludes that "everywhere in the organs, even in the sense-organs, the real cause of pain is a disturbance of tissue, in particular a disturbance of chemical sort, whereby either the quantity of the newly-formed products of destruction rises above the normal, or whereby products arise through the influence of a foreign body which are not present in the normal condition." There seems to be only one exception to this law, *i. e.*, that of the induction current. In all other cases the tissue appears as the starting point of pain, and can, if one wishes to hold to the analogy of the sense-organs, be regarded as an end apparatus for the sensations of pain. In harmony with this view, pain may be considered to arise whenever an absolutely or relatively too great stimulation for the excitability of the sensation apparatus occurs.

2. In reference to how the nervous connection between the peripheral tissue and the centre is secured, Oppenheimer is of the opinion that this connection is brought about by means of the vaso-motor nerves, in which he includes only the vaso-constrictors and

not the vaso-dilators. He is led to this view by many physiological, pathological and anatomical observations, among which are:

(a) The different sensibility to pain of different organs and parts of the body. In the cuticle, hair, nails, etc., where there are no nerves, vessels or tissues to be disturbed, there is no pain. The intestines, under splanchnic control, the lungs, with no vaso-motor nerves, etc., are, under normal conditions, insensible, but become very painful under pathological conditions. Also those organs whose connective tissue becomes changed into a more or less firm framework and whose circulation is very defective, are normally insensible to pain, but, under a new vascularization which may develop through an inflammatory process, they become quite painful, as shown in chondritis, osteitis, tendonitis, etc.

(b) The close relation which exists between pain and hyperemia. There is one form of hyperemia arising from sectioning of the vaso-motor path—neuroparalytic—in which there is no pain. This indicates that pain fails after an interruption of the vaso-motor path. In the other form of hyperemia, pain occurs so regularly with the hyperemia that it would seem that the cause of both phenomena is one and the same pathological process. "One might think that the centrifugal vaso-motor nerves and the centripetal sensory fibres are stimulated simultaneously in a nerve trunk or in the centre."

(c) The phenomena of hyperesthesia and of analgesia seem easiest explained by Oppenheimer on his assumption of vaso-motor conduction and separate paths for pain and touch. He says: "We cannot accept the view that there are nerves whose only object is pain. The assumption of pain nerves appears to me to be as unphysiological as if one should wish to assume nerves of sparkling because he once, by a blow on the eye, saw the phenomenon of sparkling. Pain is, as generally accepted, a real pathological phenomenon, *i. e.*, an expression of a physiological function under unusual conditions." In organs where activity causes but slight change, the *feeling* may be scarcely noticeable—*e. g.*, tendons, ligaments, bones. "Pain is not, as some believe, the highest degree of the sensation of a sense-organ, but the most intensive sensation which results in the vaso-motor nerves under the strongest stimulation."

Oppenheimer sums up his view in the following words, which I have translated rather freely:

1. "What until now has been called the sympathetic, consists of two nerve tracts differing completely in their anatomical arrangement. They are distinguished especially from one another in their relation to the ganglia of the sympathetic and in their manner of central distribution.

"The nerve tract known as the splanchnic arises from the spinal cord, goes in the rami communicantes to the sympathetic, the path of which it follows for a certain distance, then leaves it again in the so-called splanchnic roots, without having entered into connection with the sympathetic ganglia, and continues to the abdominal cavity. From what part of the spinal cord it arises, whether it is connected only with the anterior roots, or whether with these and the posterior, is not known.

"The other nerve tract, which may be designated as the real sympathetic, is described most correctly, as it appears to me, if the ganglion of the sympathetic is considered as its place of origin. Disregarding the fibres connecting with higher and lower ganglia, fibres radiate from it in three directions. To it run fibres out of the anterior root, and from it originate fibres which pass through the posterior root to the posterior horn (after having radiated out in

brush-like form horizontally above and below), whence they are distributed partly to the anterior horn and partly to the crossed antero-lateral column. In reference to these latter, it is not certain whether they ascend without interruption to the oblongata, or whether they reach that only after having connected the single segments of the spinal cord among themselves. With regard to the fibres that go to the anterior horn, the assumption can be made with great probability that they connect themselves with the cells of the anterior and lateral horns, from which arise the nerves which pass through the anterior root to the sympathetic.

"Finally, fibres go out from the sympathetic ganglia to the periphery, where they end in a ganglion cell, which gives off fibres for the vessels and for the tissue.

2. "The anatomical arrangement of the sympathetic is different from all other nerves in that the connection of the sympathetic ganglia with the anterior and posterior roots makes possible a centrifugal as well as centripetal conduction, and the forking in the peripheral end makes possible a second arrangement for centrifugal and centripetal conduction, of which the centrifugal serves for the innervation of the vessels, while the centripetal serves for the stimulation going out from the tissue. The single fibre between the sympathetic ganglion and peripheral ganglion cell mediates both kinds of stimulation. There moves along it in an outward direction a continual current, which arises from the anterior horn and the anterior roots and passes by the vaso-motor nerves to the vessels where it causes the vessel tonus. Now, if a current originating in the peripheral ganglion cell through the stimulation of the tissue, and running in an opposite direction should arise, an obstruction will occur in the flow of the first stream, and, in consequence, a loss of tonus will produce hyperemia in the stimulated tissue. At the same time with the obstruction which the centrifugal stream experiences in the periphery, arises a stimulation of the nerve tract, which goes from the sympathetic ganglia through the posterior root and the posterior horn to the vaso-motor cells of the anterior horn and to the antero-lateral columns. The stimulation of this nerve tract announces itself in two forms

"In the first place, on account of the spreading of the lateral nerve roots in the spinal cord, and on account of the connection which the single segments of the cord possess among themselves, not only the cells lying next the stimulated fibre above and below, but all vaso-motor centres, are set in excitation, and through this, in spite of the peripheral hyperemia, the usual mean blood pressure remains constant. The cause of this constancy of blood pressure—the chemical or physical change in the tissues—is also, taken generally, the cause of the continual excitation of the vaso-motor cells of the spinal cord and of the continuous current going out from the anterior horn, causing the vessel tonus. During life, the metabolic processes are never at rest, and an interchange of rest and activity in the individual organs is ever present.

"The second form of phenomenon is characterized by the appearance of a feeling. How and where this arises cannot yet be told. The course of the sympathetic fibres in the antero-lateral column, their relation to the oblongata, to the splanchnic and to the brain are not known. It is only certain that we have, during the quiet course of the processes of life, an indefinable common feeling (*Lebensgefühl*); that in the activity of the single organs, this feeling becomes more distinct and reaches consciousness as a sensation of the organ, and that with the strongest stimuli that reach the tissue, pain arises. It is also certain that by stimulation or inter-

ruption of the sympathetic path in the posterior horn, vaso-motor disturbances of different kinds present themselves. In the case of stimulation, hyperesthesia is observed, and in the case of interruption, analgesia.

"The specific effect of the centripetal path of the sympathetic ganglia on vessel innervation and feeling is shown, not only when in consequence of stimulation of the tissue nerves the centrifugal stream is obstructed, but also when the vaso-dilator nerves are in activity and effect an obstruction of this stream. The neuro-tonic active congestion is connected with violent pain."

3. "For the temperature sense we have no special organ as for the other senses. The temperature sensation is rather composed of two simultaneous excitations, one of which reaches the centre by the tissue nerves and the sympathetic and the other by the specific nerves of touch."

As will be seen, this theory is of a physiological nature, basing the origin of pain on a chemical change of the tissues. The theory is unique in its departure from trodden paths, and seems to answer many of the known facts in a very satisfactory manner, especially the pains of fatigue, hyperemia, etc. Nevertheless, the assumption that the tissues act as end-organs for pain and that the vaso-motor nerves form the path for its conduction, would hardly seem probable.

Among those who have written on the different cutaneous sensations, the name of Dr. Alfred Goldscheider holds the first rank. He has touched on the subject of pain in several of his writings, and in his late work, "*Über den Schmerz*," he has devoted his attention to pain alone. In a former article (*Du Bois-Reymond's Archiv*, 1885; Supp., p. 87), Goldscheider calls attention to pain-points, which led many to credit him with believing in specific nerves of pain; but, contrary to von Frey, Goldscheider believes that these pain-points are not specific organs of pain. He believes simply that in consequence of especially exposed nerve endings, stretched tissues, etc., less stimulation will produce pain in those regions. Pressure-points always respond painfully when the stimulus is intense, but thermal-points cannot be excited painfully. He says: "The so-called temperature-pain is an association of a real temperature sensation with a painful excitation of the nerves of feeling (*Gefühlsnerven*)."¹ The temperature sensation, as such, may be in the highest degree unpleasant, but never goes over into real pain.

As to the nature of pain, Goldscheider reiterates his former view: "that the sensation of pain is peculiar to the pressure nerves and the nerves of common feeling (*Gemeingefühlsnerven*), but fails in all other sense nerves. Sensations of other sense nerves may be unpleasant, but not really painful." This view is similar to that of Spiess (R. Wagner's *Handwörterbuch der Physiologie*). According to this view, pain is a special quality of the sensation and not a modification of the sensation common to every different quality.

Pains from inflammation are thought by Goldscheider to be due to increasing pressure, and by Oppenheimer to be due to chemical changes and chemical products. As to the origin of pain in general, Goldscheider believes it to be due to a process of summation in the gray substance of the spinal cord. Ch. Richet showed that a series of homogeneous shocks will cause pain, when the shocks singly are too weak to be perceived, and Naunyn found similar results, as already mentioned.

Goldscheider accounts for the phenomenon of summation and secondary sensation by assuming, in harmony with Funke and Wundt (*Phys. Psych.*, 4th ed., Vol. I., pp. 111, 112), "that the sensory

paths are divided in the spinal cord; the excitation runs along the posterior column to the conscious centre, probably only once or twice interrupted by ganglion cells; and, on the other hand, it hits on the way the collaterals of the gray substance, and this not only conducts the excitation, but also brings about a changed excitable condition in the cells. These, after more stimulation, will give forth the stored-up energy, which will likewise be conducted to the sensorium." Two possibilities are here present, "either the pain stimulus is conducted through the gray substance to an especial pain centre, or the path through the gray substance possesses itself the condition which allows the increasing of the excitation until it becomes painful." Goldscheider, like Wundt, holds to the latter view. According to this view, the same peripheral nerves that conduct the heat, cold, or pressure impulses, also conduct the pain impulse, or, perhaps, rather the excessive stimulus which is to produce pain. When these impulses reach the cord, they find separate paths, a primary path through the white fibres of the posterior column and a secondary path through the gray column. Impulses of moderate intensity are conducted along the primary column, but when the impulses are intensive, they overflow through the gray column, where their progress is retarded.

Goldscheider believes, as shown by H. Head (*Brain*, 1893), that pain is due to an increasing sensitiveness in the spinal ganglion cells. Here is where the real change in the stimulus that produces pain takes place. The real source of the pain, then, is in the ganglion cells of the spinal cord. There are two conditions which call forth the increasing excitableness (hyperalgesia) of the sensory spinal cells: the falling out (*Ausfall*) of the spinal paths of conduction, and autochthonic irritability. Goldscheider's position seems to be that all impulses of pressure, for instance, whether excessive or not, are conducted along the same peripheral nerves until they reach the posterior horn, whence, under normal conditions, they pass up the posterior column to the sensorium unchanged, and are perceived as pressure; but, if the impulses are excessive, or the conductivity of the posterior column is weakened, they are conducted by the collaterals to the gray column, where they undergo a transformation, due to the stored-up energy of the ganglion cells, and on account of this change are conducted to the sensorium as pain impulses.

Pain is thus a new element added to other sensations. It seems right to say a new sensation, but as both paths may be conducting the impulses together, it may not be best to look on pain as a separate sensation. According to this view, real pain is due to excessive stimulation of the pressure or common feeling nerves, or to a hypernormal condition of the gray substance of the cord, and, therefore, might better be called an intensive degree of a sensation than a quality.

The different qualities of pain are not due to the pain element itself, but are due to the different sensations with which the pain element is constantly mixed. Pains are of one kind, but are colored by the tones of other sensations. In reference to heat pain, Goldscheider believes it to have no more to do with the temperature sense than the pain which occurs on cauterizing the tongue with sulphuric acid has to do with the acid taste which appears alone with a weakened solution of the acid. It is, however, a pain of the nerves of common feeling through the influence of different temperatures accompanied by maximum sensations and peculiarly colored by them.

"To the cutaneous pains are added the character of sharp locali-

zation; to the pain of muscles is added a diffuse spreading and a feeling of depth, because the overlying skin is perceived as free of pain. The joint pain is frequently connected with a feeling of warmth along with a feeling of stiffness, because the least movement in the joint increases the pain." Along with each pain, therefore, there are other sense contents which give to the pain its peculiar coloring. Goldscheider follows Erb's classification of the different pain qualities, according to which the pains are determined: (a) Through the continual mixing of sense perceptions, as burning, itching, etc., pains. (b) Through the localization and diffusion, as aching, piercing, etc., pains. (c) Through the change of exciting process, as throbbing, etc., pains.

Under the heading of "Pain as a Symptom of Diseases," Goldscheider makes three classes: First, the real pain sensation (*echte Schmerz-Empfindung*). This belongs only to the nerves of common feeling and the pressure nerves, and is brought about by real pain-exciting stimuli (mechanical, chemical, thermal, inflammatory and toxic pains, etc.). In the second class of pains there is present abnormal excitement of the nerves, but not so intense that it should lead to such pain. Sensations, in themselves not painful, by their continuation or their occurrence in unusual places are clothed at first with a feeling of annoyance, and later become painful. This second class is designated as pain of discomfort (*Schmerzweh*),—*dolor spurius*, unreal, indirect, or pseudo-pain. Many of the pains occurring in sickness are of this sort — most headaches, many stomach pains, etc. They are more oppressive and tormenting than the real painful pressure, or tension sensations. In both these classes of pain there is some local suffering of the nervous system, but the mind is not affected. It is entirely otherwise with the third form of pain, which rests on an abnormally increased central excitability, a kind of psychic hyperesthesia. It is "a 'psychic,' or better, an ideal (*ideeler*) pain." This hyperesthesia of sensitive mental activity, we find designated in neuro-psychoses as neurasthenia, hysteria, hypochondria, etc. It is developed mostly on the ground of heredity, or from an existing disposition due to long sickness, mental overwork, continuous anxiety, etc., all of which bring about a changed psychic activity. Hypnotic and hallucinatory pains are treated under this head. The physical and psychic pains are not antagonistic. They do not exclude each other, but, on the contrary, may combine with one another. Also a real (physical) pain by frequent repetition, or by long duration, may cause psychic hyperalgesia. The above seems to be an important as well as correct classification of the pains occurring in sickness.

Goldscheider's theory of pain is more attractive to the writer than any of the others presented. It may be necessary to modify his view that temperature points are analgesic in order to explain those tabetic cases where there is hyperalgesia to temperature without hyperalgesia to touch. (Starr: "Familiar Forms of Nervous Disease," pp. 173-175.) It cannot be said to be final, as there are still some facts not answered by it, but it avoids many difficulties. By it, analgesia, whether the result of anaesthesia, hypnotism, or hysteria, is easily explained, for anything destroying the collateral fibres, or lowering the excitability of the gray substance, would destroy pain. It is easy to see how a lesion of the cord might cause anaesthesia or analgesia, depending on the location of the disturbance. Also, how in visceral disturbance, etc., the pain may be referred to peripheral parts of the body, these peripheral parts having their nerve roots in the same segment of the cord as the part of the internal organ disturbed. The secondary sensation, as well as in-

creased and decreased sensibility, can be better explained by conceiving the source of pain in the gray substance of the cord.

As Goldscheider suggested, one may laugh at the idea of the pain of an ingrowing nail being located in the cord, yet the sensory nerve fibre which passes from the toe to the posterior root of the cord, is simply the prolongation of a nerve cell situated in the posterior horn, a structure which acts as a unit. Everybody knows how frequently a disturbance of the stomach may produce pains in the head.

It seems rather unfortunate to be forced to make so much of the nerves of common feeling, nerves which are almost as vague and indefinite as the hypothetical pain nerves. They seem to be the scapegoat for all excitations which can not be accounted for through the nerves already known.

To the writer the distinction between real, direct pain produced by artificial stimulation, local inflammation, neuralgia, etc., and the general pains of discomfort, caused by disturbed nutrition or circulation and general change of nervous functioning, etc., seems to be an important one. The real pains seem a totally disparate sensation. This view would harmonize with the manner of their production in the gray substance as well as agree with their separation in time from touch and other sensations on the way to the sensorium. Real pain cannot be said to belong to the higher senses—sight, hearing, smell, taste,—and cannot properly be treated as the opposite of pleasure. The pains of discomfort, on the other hand, seem to me to be fairly the opposite of pleasure, and properly considered as the feeling-tone of the sensation. They belong to all sensations, and are made up from the complex half-unconscious sensational and ideational elements brought to consciousness along with the sensation.

Both pleasure and the pain of discomfort are general, diffused and complex in their nature, while real pain is definite, generally well localized, and simple. Attention and association, as well as the mental and bodily states, play here an important rôle, and the theories making pleasure and pain in this sense opposite *qualia* of a sensation may not be far wrong.

G. W. A. LUCKEY.

II. NEUROLOGICAL.

C. F. HODGE, PH. D.

The Growth of the Brain. A Study of the Nervous System in Relation to Education. HENRY HERBERT DONALDSON. The Contemporary Science Series. Walter Scott, London, 1895, pp. 374, 77 illustrations and 64 tables.

But a single trial is allotted to each to develop a "sound mind in a sound body." A realization that to the attainment of this end some knowledge of the laws governing the growth of by far the most important organ concerned, the brain, might be of service, has been rapidly dawning, and the present book has been awaited by a goodly audience who are interested in the problem of highest development. Physicians, teachers and parents, whose needs, as stated in the preface, the author has in view, certainly form a large proportion of society.

No book in any language attempts to cover the field as this one does. What Exner's "*Entwurf zu einer physiologischen Erklärung*